

Photospheric Magnetic Flux Transport – Supergranules Rule

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Observations of the transport of magnetic flux in the Sun's photosphere show that active region magnetic flux is carried far from its origin by a combination of flows. These flows have previously been identified and modeled as separate axisymmetric processes: differential rotation, meridional flow, and supergranule diffusion. Experiments with a surface convective flow model reveal that the true nature of this transport is advection by the non-axisymmetric cellular flows themselves - supergranules. Magnetic elements are transported to the boundaries of the cells and then follow the evolving boundaries. The convective flows in supergranules have peak velocities near 500 m/s. These flows completely overpower the superimposed 20 m/s meridional flow and 100 m/s differential rotation. The magnetic elements remain pinned at the supergranule boundaries. Experiments with and without the superimposed axisymmetric photospheric flows show that the axisymmetric transport of magnetic flux is controlled by the advection of the cellular pattern by underlying flows representative of deeper layers. The magnetic elements follow the differential rotation and meridional flow associated with the convection cells themselves – supergranules rule!